

The roof of the large auditorium was nearly intact, but near its south-east end a great hole was torn in it, say twenty feet square, and the piece, which was intact, seemed to have been blown upward, twisted almost completely around, and then dropped back into nearly its original position.

Now in each of these buildings there was a large amount of air inclosed, with no dividing partitions. According to my view the tornado simply took the air pressure off their sides and tops, and in consequence the inclosed air expanded from within and did the greater portion of the damage. It was not the force of the wind outside, but mainly the expansion of the confined air, that wrecked the buildings. Suppose that such public buildings should be so made that a space of, say, ten feet, all around just beneath the roof, could yield to a moderate pressure from within, would not the roof remain intact and the walls remain vertical?

HAILSTONES.

A few days ago I examined some hailstones under a small-power microscope. It has been said that hailstones all have a snowball for a nucleus. I think that this is a mistake. The white central sphere of the hailstone, inclosed in its rim of crystal, glassy ice, is simply normal ice. Put some water in a drachm vial and freeze it in a tumblerful of freezing mixture, consisting of two parts by weight of ice to one of salt, hold it up to the light, and you will find a central core of white amorphous ice, with crystalline ice enveloping it on all sides. There is no snowball to start with in this instance; the freezing always begins on the top, bottom, and sides, and the liquid center freezes last. I fully believe the hailstone is first a spherical drop of water; then its outermost rim reaches 32° F. in the surrounding cold, congeals, and the congelation gradually extends inward till the last of the liquid content becomes solid. Water can not be frozen in a tube or in any sort of way so that it will not be white in the center if the cold strikes it on all sides. Boil water, pour castor oil on it before it has a chance to reabsorb the three per cent of air that naturally belongs to it, freeze it, and you get amorphous ice (never crystalline), looking like paraffine. The central core is larger in the hailstone, in proportion, than it would be in a piece of ice of the same diameter frozen naturally in a tube or other vessel. This is because hail forms four to eight miles above the ground and there is less air in the water at that height than at the ground, where the pressure is 30 inches.

I think that large hailstones are simply aggregations and clusters of hail. Melt the top of a block of ice so that it is covered with moisture, cover it with another block of ice, and the two will unite solidly, even when the temperature outside is above 32° and the outsides of both blocks are in a melting state.

THUNDERCLOUDS.

A thundercloud is composed of fog particles, these particles being much smaller, according to the laws of gravity, at the top than at the broad black base. It seems to me that meteorologists generally teach that it is the condensation and coalescence of these particles that form raindrops, and that this coalescence takes place by the action of cold, and that it begins when the dew-point is reached. This is true in regard to fog particles only, and fog particles have still further to be condensed before they lose their spherical shape, and this requires a much greater degree of cold than any one seems to have thought necessary so far as I can learn. Mists above rivers or fogs on the coast are seen when the temperature is far below freezing. In other words, fog particles will not coalesce at temperatures below freezing.

We will suppose the peak of a thundercloud to reach eight and one-half miles. That height on a summer day has a temperature of at least —50° F., and yet you see before you a mass of vapor, boiling and seething, just as steam from an engine does on a cold morning. Heat from below is continually being supplied, and however cold the interior of the cloud may be, it is evidently not sufficiently so to consolidate the vapor. The very moment, however, that the vapor reaches the top edge of the cloud and encounters —50° F. of cold, each spherical fog or cloud particle is so constricted upon its inclosed, now much rarefied, air particle that the latter forces its way out just like the bursting of a soap bubble, and now instead of a film of water surrounding a globule of air you will have left a tiny mass of genuine, unadulterated water. This has appreciable weight, falls downward, rupturing by contact in its descent countless ascending fog particles, coalescing with them, and by the time the base of the cloud is reached a large drop of rain has been formed. Thus rain begins at the very top layer of the mass of fog particles and nowhere else. The higher the cloud, and the greater the number of fog particles encountered in the descent, the harder the rain. Every thundercloud shows the rain streak directly below the peak. A flash of lightning or peel of thunder is never noticed till those rain streaks appear below.

We print the above as coming from a close observer and logical reasoner, but doubtless others will differ from him as to facts and theories. The formation of hail and rain is not yet well understood. We hope that others will contribute to this subject; observations, theories, and experiments by careful physicists are much to be desired.—Editor.

FORECASTS AND WARNINGS.

By Prof. E. B. GARRIOTT, in charge of Forecast Division.

North Atlantic weather was not notably severe. Barometric pressure continued low over the British coasts. After the 4th high barometric pressure and settled weather prevailed over the Azores.

Ten areas of low barometer moved eastward over or near the Canadian Maritime Provinces, one of which advanced from the Gulf of Mexico, one from the subtropical region north of Cuba, and one from the north Pacific coast of the United States; the remaining low areas first appeared over the interior of the North American Continent.

Over the greater portion of the United States the month was exceptionally mild, and in parts of the Missouri and Red River of the North valleys the mean temperature for the month was 10° to 12° above the normal. Precipitation was irregularly distributed, and there was a general deficiency in snowfall.

In the Atlantic coast States the barometric depressions were of moderate intensity. Several energetic storms crossed the Great Lakes, those of the 3d–4th, 5–6th, and 14–15th being the most severe. The principal storms of the Pacific States occurred during the second decade of the month.

Attending low area I heavy snow fell in New Mexico on the 1st, and heavy rain in the lower Mississippi Valley on the 2d. On the 3d the barometer fell to 28.68 inches at Madison, Wis., at 8 p. m., snow fell in Iowa, Minnesota, Wisconsin, and Upper Michigan, heavy rain generally east of the Mississippi, and a strong gale prevailed over the upper Lakes. A tornado is reported as having visited Albany, Ga., at 2:30 p. m. Snow continued in the Lake region during the 4th. In connection with low area II high winds prevailed from the Great Lakes over the middle Atlantic and New England coasts. During

the passage of low area III snow fell in the Ohio Valley and the Atlantic States to and including North Carolina on the 8th.

From the 12th to 14th low area IV moved northeastward off the Atlantic coast with gales that attained a reported maximum velocity of 67 miles an hour from the northeast at Nantucket, Mass., on the 14th. From the 11th to 13th low area VI caused heavy rain and high winds, on the Pacific coast. During the 15th and 16th low area VII passed northeastward over the Lake region, with rain from the lower Mississippi Valley over the Ohio Valley and Great Lakes. From the 16th to 18th low area VIII crossed the continent from the north Pacific coast to the Canadian Maritime Provinces. On the 22d heavy rain fell in the lower Mississippi Valley, and rain, sleet, and snow in the middle and upper Mississippi valleys, and on the 22d heavy rain was general from the Ohio Valley over the middle and east Gulf States, and snow fell over the upper Lakes. On the 26th heavy precipitation attended the passage of low area XI northeastward off the Atlantic coast, and snow was reported in the interior of South Carolina and Georgia.

The first and most important cold wave of January advanced over the interior and eastern parts of the country from the 19th to 24th, breaking a period of exceptionally high temperature that had continued generally east of the Rocky Mountains from the beginning of the month. During the 30th and 31st a moderate cold wave advanced from Manitoba over the Red River of the North and the upper Mississippi valleys.

Heavy frost occurred on the middle coast of the Gulf of Mexico on the 1st, 9th, 14th, 23d, and 24th, and on the Texas coast on the 24th and 25th. Freezing temperatures were reported at New Orleans, Mobile, and Pensacola on the 9th, 23d,

and 24th, and at Corpus Christi on the 23d and 24th. From the 1st to 5th heavy frost was reported daily in southern California.

BOSTON FORECAST DISTRICT.

The mean temperatures of the month were decidedly above normal in all sections, and the maximum readings that occurred from the 21st to the 24th were among the highest recorded in the January official observations. The warm weather during the period mentioned caused buds to start on some trees and leaves to appear on shrubs in sheltered places in central and southern sections. Ice disappeared from many streams and ponds. There was an absence of severe storms, with the exception of the storm of the 14-15th, when wind velocities of from 40 to 67 miles an hour occurred at coast stations. So far as known at this office no damage resulted from the gales. The precipitation of the month was generally much below the monthly average, and the greater portion of it occurred as rain. The light snowfall was unfavorable to the lumbering interests, and, owing to the prevalence of mild weather, there has been little ice harvested. There were no storms during the month with high winds for which warnings were not ordered.—*J. W. Smith, District Forecaster.*

NEW ORLEANS FORECAST DISTRICT.

High winds prevailed along the west Gulf coast on the 9th and 22d, for which timely warnings were issued. No high winds occurred without warnings. Two general cold waves passed over the district during the month, one on the 8th and 9th and another on the 21st and 22d. Frost or freezing temperature warnings were issued for the sugar and trucking regions of Texas and Louisiana for every injurious condition that occurred during the month.—*I. M. Cline, District Forecaster.*

CHICAGO FORECAST DISTRICT.

Advices of impending storms were sent to open ports on Lake Michigan during the month. A well-marked storm developed in the southwest early in the month and reached the middle Mississippi Valley on the morning of the 3d, at which time messages advising the various interests that severe and dangerous gales would occur were issued. The storm continued to develop great energy and moved directly across the Lake region, accompanied by general gales for 24 hours. Advices were sent out on the 4th that the storm would gradually lose force. There was no other severe storm until the 15-16th. Advisory messages were issued in advance of this storm. The storm which appeared in the Pacific coast region on the 17th moved very slowly southeastward and thence northeastward over the Lake region, reaching the Lakes by the morning of the 22d and causing high winds until the morning of the 23d. Advices were sent out 24 hours in advance of its occurrence.

There was no general cold wave during the month, although the temperatures were very low in the northwest from the 21st to the 23d. Cold-wave warnings were issued on the 19th, 20th, 21st, and 22d, resulting finally in a display at all stations. The warnings were verified at the majority of the stations, and a remarkable fall in temperature occurred at practically all points, although limiting temperatures were not reached in some cases. No other general cold-wave warnings were issued. The chief value of the warnings lay in the fact that abnormally high temperatures for the season had previously prevailed. This storm was accompanied by rain, changing to sleet and snow, which caused great damage to telephone and telegraph lines. The temperatures were, as a rule, far above the normal over the greater portion of the district, and it was the warmest January since 1880.—*H. J. Cox, Professor and District Forecaster.*

LOUISVILLE FORECAST DISTRICT.

The month was unusually mild and fair, there being only two periods, 8-9th and 23d to 26th, when the temperature was below normal. On the 20th and 21st the temperature was 70° to 80° over the greater portion of Kentucky and Tennessee, the highest generally for January since the establishment of the

National Weather Bureau Service. Thunderstorms were quite general on the 15th. Three general storms passed across or near the district during the month, giving rain and high winds; these occurred 2-3d, 14-15th, and 20th-22d. The month was remarkably free from snow, there being only one snowstorm, on the 8th, over any great portion of the district. On the 26th snow fell quite heavily in the mountain portions of Kentucky and Tennessee, but none elsewhere in either State. Cold-wave warnings were issued the night of the 7th and morning of the 8th, and again on the 20th and 21st. These warnings were fully justified.—*F. J. Walz, District Forecaster.*

DENVER FORECAST DISTRICT.

In western Montana and in the mountain districts of the western slope the month was cold, with here and there an excess of precipitation, while mild and dry weather was almost continuous in the plains region of the eastern slope. In southwestern Colorado the stormy period of the 18th, 19th, and 20th, which was forecast, was followed by the most destructive snow slides in the history of San Juan district. Five lives were lost from this cause, and the Denver and Rio Grande Railroad was blocked for thirteen days in Animas Canyon. The greatest depth noted in connection with these slides was 63 feet. The most important cold wave of the winter followed the low pressure area that overlay the middle Rocky Mountain region on the morning of the 20th. Timely warnings were given full distribution in southern Wyoming, northern Arizona, southwestern and eastern Colorado, and northern and eastern New Mexico, which was the area covered by the cold wave.—*F. H. Brandenburg, District Forecaster.*

SAN FRANCISCO FORECAST DISTRICT.

The month, as a whole, was pleasant, the condition during the early portion being favorable for heavy frost generally in the interior of California. Ample warning was given to fruit growers, and losses due to frost were therefore small. On the morning of the 11th a general warning of rain and southerly winds was issued, and the storm that followed broke a prolonged dry period that was beginning to seriously interfere with farming operations. Ample warning was also given to river interests concerning the probable effect of the heavy rains upon river heights. The third decade, like the first, was dry.—*A. G. McAdie, Professor and District Forecaster.*

PORTLAND FORECAST DISTRICT.

The stormy period of the month was between the 11th and the 25th, during which time four noteworthy disturbances passed across the district. The third one evidently resulted from the coalescence of two minor disturbances, which were first noted over Nevada and western British Columbia, respectively. It moved east across the southern portion of the district. The last one made its appearance off Cape Flattery on the evening of the 21st, and moved slowly northeastward. The steamer *Valencia* was wrecked on Vancouver Island during the passage of the last storm and 117 lives were lost. From the 25th to the end of the month, the weather was controlled by a stagnant high pressure area which settled over southern Idaho, and but little precipitation occurred thereafter. Timely warnings were issued for all gales. No cold waves occurred and no cold-wave warnings were issued.—*E. A. Beals, District Forecaster.*

RIVERS AND FLOODS.

Owing to the continued absence of normal winter conditions, river stages were generally higher than is usual during the month of January. Temperatures were high and rainfall abundant, and, as a consequence, the great rivers were well supplied with water, while moderate floods occurred in many of the smaller rivers. Danger-line stages were exceeded in a number of these floods with the usual accompaniment of flooded lowlands. Along the headwaters of the Tennessee